

Claims

- [c1] 1. A method for controlling a turbocharged internal combustion engine having at least two turbochargers, the method comprising:
 - operating the turbochargers in a series configuration for a first operating region; and
 - operating the turbochargers in a parallel configuration for a second operating region.
- [c2] 2. The method of claim 1 wherein the first and second operating regions correspond to demanded airflow.
- [c3] 3. The method of claim 1 wherein the at least two turbochargers include first and second turbochargers having corresponding first and second compressors, respectively, and wherein the step of operating the turbochargers in a series configuration comprises selectively connecting an outlet of the second compressor to an inlet of the first compressor.
- [c4] 4. The method of claim 1 wherein the at least two turbochargers include a first and second turbocharger having corresponding first and second turbines, respectively, and wherein the step of operating the turbocharg-

ers in a series configuration comprises selectively connecting an outlet of the first turbine to an inlet of the second turbine.

- [c5] 5. The method of claim 1 wherein the at least two turbochargers include a first and second turbocharger having respective first and second turbines and compressors, and wherein the step of operating the turbochargers in a series configuration comprises:
 - selectively connecting an outlet of the second compressor to an inlet of the first compressor; and
 - selectively connecting an outlet of the first turbine to the inlet of the second turbine.
- [c6] 6. The method of claim 5 further comprising selectively supplying a portion of exhaust gas from downstream of the first turbine to the inlet of the first compressor.
- [c7] 7. The method of claim 1 wherein the at least two turbochargers include first and second turbochargers having corresponding first and second turbines and compressors, the method further comprising:
 - supplying a portion of exhaust gas to an inlet of the first compressor and outlet of the second compressor when operating in the series configuration; and
 - supplying a portion of the exhaust gas to the outlet of the second compressor only when operating in the par-

allel configuration.

- [c8] 8. The method of claim 7 further comprising:
 - supplying a portion of exhaust gas from downstream of the first turbine to an inlet of the first compressor when operating in the series configuration; and
 - supplying a portion of the exhaust gas from upstream of the second turbine to the outlet of the second compressor only when operating in the parallel configuration.
- [c9] 9. The method of claim 1 wherein the at least two turbochargers include first and second turbochargers having corresponding first and second compressors, respectively, and wherein the step of operating the turbochargers in a parallel configuration comprises:
 - decoupling an outlet of the second compressor from an inlet of the first compressor; and
 - coupling the outlet of the second compressor to an intake manifold of the internal combustion engine.
- [c10] 10. The method of claim 9 wherein the first and second turbochargers include corresponding first and second turbines, respectively, and wherein the step of operating the turbochargers in a parallel configuration comprises:
 - decoupling an outlet of the first turbine from an inlet of the second turbine; and
 - coupling the outlet of the first turbine to atmosphere.

[c11] 11. The method of claim 10 wherein the internal combustion engine includes first and second after-treatment devices disposed downstream of outlets of the first and second turbines, respectively, the method further comprising:
selectively directing at least a portion of exhaust gas from the outlet of the second turbine to the first after-treatment device based on current operating conditions.

[c12] 12. A system for turbocharging an internal combustion engine, the system comprising:
first and second turbochargers each having an associated compressor and turbine;
a plurality of flow control devices for selectively routing intake and exhaust flow to and from the first and second turbochargers; and
a controller in communication with the plurality of flow control devices, the controller selectively actuating the plurality of flow control devices to operate the first and second turbochargers in one of a series configuration and a parallel configuration based on current operating conditions.

[c13] 13. The system of claim 12 further comprising at least one EGR valve in communication with the controller for selectively providing exhaust gas recirculation, the con-

troller selectively actuating the EGR valve in combination with at least one of the plurality of flow control devices to supply a portion of exhaust gas to an inlet of the first compressor when operating the turbochargers in the series configuration and to an outlet of the second compressor when operating the turbochargers in the parallel configuration.

- [c14] 14. The system of claim 12 further comprising at least one EGR valve in communication with the controller for selectively providing exhaust gas recirculation, the controller selectively actuating the EGR valve in combination with at least one of the plurality of flow control devices to supply a portion of exhaust gas from downstream of the first turbine when operating the turbochargers in the series configuration and upstream of at least one of the first and second turbines when operating the turbochargers in the parallel configuration.
- [c15] 15. The system of claim 12 further comprising at least one EGR valve in communication with the controller for selectively providing exhaust gas recirculation, the controller selectively actuating the EGR valve in combination with at least one of the flow control devices to supply a portion of exhaust gas from upstream of the first and second turbines to an inlet of one of the compressors when operating in the series configuration, and an outlet

of at least one of the compressors when operating in the parallel configuration.

- [c16] 16. The system of claim 12 wherein the controller operates the turbochargers based on current operating conditions including at least demanded airflow.
- [c17] 17. The system of claim 12 wherein the controller actuates the plurality of flow control devices to couple an outlet of the second compressor to an inlet of the first compressor when operating the turbochargers in the series configuration.
- [c18] 18. The system of claim 12 wherein the controller actuates the plurality of flow control devices to couple an outlet of the first turbine to an inlet of the second turbine when operating the turbochargers in the series configuration.
- [c19] 19. The system of claim 12 wherein the controller actuates the plurality of flow control devices to couple an outlet of the second compressor to an inlet of the first compressor and to couple an outlet of the first turbine to an inlet of the second turbine when operating the turbochargers in the series configuration.
- [c20] 20. The system of claim 12 wherein the plurality of flow control devices comprises:

a first intake valve for selectively coupling an inlet of the first compressor to ambient or an outlet of the second compressor; and

a second intake valve for selectively coupling an outlet of the second compressor to an intake manifold or the inlet of the first compressor.

[c21] 21. The system of claim 12 wherein the plurality of flow control devices comprises:

a first exhaust valve for selectively coupling and decoupling an inlet of the second turbine to an exhaust manifold; and

at least one additional exhaust valve for selectively coupling an outlet of the first turbine to ambient or an inlet of the second turbine.

[c22] 22. The system of claim 12 further comprising:

first and second after-treatment devices disposed downstream of the first and second turbines, respectively; wherein the plurality of flow control devices comprises an exhaust valve for selectively coupling an outlet of the second turbine to the first after-treatment device.

[c23] 23. A computer readable storage medium having stored data representing instructions executable by a computer for controlling a turbocharged internal combustion engine having at least two turbochargers, the computer

readable storage medium comprising:
instructions for operating the turbochargers in a series configuration for a first operating region; and
instructions for operating the turbochargers in a parallel configuration for a second operating region.

- [c24] 24. The computer readable storage medium of claim 23 wherein the engine includes a plurality of valves for selectively reconfiguring the turbochargers for operation in the series configuration and the parallel configuration, and wherein the instructions for operating the turbochargers in a series configuration comprise instructions for actuating the plurality of valves to couple an outlet of a first compressor to an inlet of a second compressor and to couple an outlet of a second turbine to an inlet of a first turbine.
- [c25] 25. The computer readable storage medium of claim 23 wherein the instructions for operating the turbochargers in a parallel configuration include instructions for actuating a plurality of valves to connect the turbocharger compressor inlets to ambient and outlets to an intake manifold.